Geophysical Research Abstracts
Vol. 17, EGU2015-8618, 2015
EGU General Assembly 2015

(When and where) Do extreme climate events trigger extreme ecosystem responses? – Development and initial results of a holistic analysis framework

Eva K. Hauber and Reik V. Donner

Potsdam Institute for Climate Impact Research, Research Domain IV - Transdisciplinary Concepts & Methods, Potsdam, Germany (reik.donner@pik-potsdam.de)

In the context of ongoing climate change, extremes are likely to increase in magnitude and frequency. One of the most important consequences of these changes is that the associated ecological risks and impacts are potentially rising as well. In order to better anticipate and understand these impacts, it therefore becomes more and more crucial to understand the general connection between climate extremes and the response and functionality of ecosystems. Among other region of the world, Europe presents an excellent test case for studies concerning the interaction between climate and biosphere, since it lies in the transition region between cold polar and warm tropical air masses and thus covers a great variety of different climatic zones and associated terrestrial ecosystems. The large temperature differences across the continent make this region particularly interesting for investigating the effects of climate change on biosphere-climate interactions. However, previously used methods for defining an extreme event typically disregard the necessity of taking seasonality as well as seasonal variance appropriately into account. Furthermore, most studies have focused on the impacts of individual extreme events instead of considering a whole inventory of extremes with their respective spatio-temporal extents.

In order to overcome the aforementioned research gaps, this work introduces a new approach to studying climate-biosphere interactions associated with extreme events, which comprises three consecutive steps:

(1) Since Europe exhibits climatic conditions characterized by marked seasonality, a novel method is developed to define extreme events taking into account the seasonality in all quantiles of the probability distribution of the respective variable of interest. This is achieved by considering kernel density estimates individually for each observation date during the year, including the properly weighted information from adjacent dates. By this procedure, we obtain a seasonal cycle for each quantile of the distribution, which can be used for a fully data-adaptive definition of extremes as exceedances above this time-dependent quantile function.

(2) Having thus identified the extreme events, their distribution is analyzed in both space and time. Following a procedure recently proposed by Lloyd-Hughes (2012) and further exploited by Zscheischler et al. (2013), extremes observed at neighboring points in space and time are considered to form connected sets. Investigating the size distribution of these sets provides novel insights into the development and dynamical characteristics of spatio-temporally extended climate and ecosystem extremes.

(3) Finally, the timing of such spatio-temporally extended extremes in different climatic as well as ecological variables is tested pairwise to rule out that co-occurrences of extremes have emerged solely due to chance. For this purpose, the recently developed framework of coincidence analysis (Donges et al., 2011; Rammig et al. 2014) is applied. The corresponding analysis allows identifying potential causal linkages between climatic extremes and extreme ecosystem responses and, thus, to study their mechanisms and spatial as well as seasonal distribution in great detail.

In this work, the described method is exemplified by using different climate data from the ERA-Interim reanalysis as well as remote sensing-based land surface temperature data.

References:
Donges et al., PNAS, 108, 20422, 2011
Lloyd-Hughes, Int. J. Climatol., 32, 406, 2012

Rammig et al., Biogeosc. Disc., 11, 2537, 2014
Zscheischler et al., Ecol. Inform., 15, 66, 2013